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PHYSICAL PAPERS.

I. *Observations on Prismatic Colours*, by Doctor SAMUEL
TENNEY, of Exeter, F. A. A.

Exeter, 24th March, 1791.

DEAR SIR,

I HAVE long entertained some doubts of the accuracy of Sir Isaac Newton's theory of colours : and as "*Nullius addiētus jurare in verba magistri*," is the general motto of modern enquirers after truth, I hope, that a modest attempt to point out an error in it, accompanied with a sincere wish to have my own opinion rectified, if it should appear to be wrong, will not be esteemed an act of disrespect to so great a name.

The part of Sir Isaac's theory, with which I am dissatisfied, is the number of colours inherent in the rays of light. That a pencil of rays is uniformly separated by the prism, into seven portions, exhibiting each a different colour, is evident to the sight ; and that all other colours are made up of different combinations of these, follows of course. That some of the prismatic colours are also mere compounds, I shall endeavour to prove.

The justness of Sir Isaac's *Rules of philosophizing* has never, to my knowledge, been called in question. One of these directs us to "admit no more causes of any phenomenon than are necessary for explaining it" :—and another asserts, that

that “to natural effects of the same kind, we are, as far as may be, to assign the same causes.” Let us first examine the doctrine by these rules.

Three of the prismatic colours we may every day, see produced by composition. *Orange* is evidently composed of red and yellow ; *green*, of yellow and blue ; and *purple*, of blue and violet. Nature, in the vegetable kingdom, is continually producing and destroying them. Unripe oranges are green ; as they ripen, the blue particles give place to red ; which, with the more fixed yellow, form the colour denominated from the fruit. The green colour of many plants is changed, as they decay, into some of the shades of yellow, by the escape of those particles which reflect blue rays. And almost every body knows, that cloths are coloured green, by being dipped successively in blue and yellow dyes. Purple may, in like manner, be produced by a mixture of blue and violet liquors or powders.

Now, is it consistent with the above cited rules to admit orange, green, and purple to be compound colours in all terrestrial bodies ; and at the same time to assert, that they are simple and original in the rays of light ? Is it not rather totally repugnant to them both ? Further, writers on the subject allow, that all natural colours, not excepting white, may be imitated by a mixture of proper proportions of red, yellow, blue, and violet. Whence then, arises the necessity of admitting three others to exist in light ? But, if orange, green, and purple be really original colours, inherent in the rays of light, how does it happen, that these alone are capable of being imitated by composition ? On Sir Isaac’s theory, these
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queries do not appear to me to admit of a satisfactory solution.

To this reasoning, it may probably be answered, that in all enquiries of this kind, theory, however plausible, must ever give way to experiment. The prism actually separates a pencil of rays of light into seven distinct colours : they must therefore, exist in it. To this I would reply, that we ought not to suffer ourselves to be deceived by appearances. In chemical decompositions, we know, that most of the substances obtained are themselves compounded ; and may, by another process, be again separated into more simple bodies. Why may not this be true of some of the colours, produced by the prismatic decomposition of light ? In fact, I strongly suspect a fallacy in the experiment, which has given rise to a false deduction. Did either of the three colours, which we find to be producible by composition, hold the first, or the last place in the prismatic series ; or, were any two of them found together, no further proof of their simplicity could reasonably be demanded. But instead of this, they appear precisely in the places, which they ought to possess, on the supposition of their being compounded. Orange is found between red and yellow ; green, between yellow and blue ; and purple, between blue and violet.

The existence of all the colours discovered by the prism, as simple and original, depends entirely on the truth of a postulatam, which I apprehend has never been fully established, viz. that the prism effects a complete separation of the different coloured rays. For if the separation be imperfect, intermediate colours must be produced. Now, can
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it be proved, that all rays of the same colour possess precisely the same degree of refrangibility? Two circumstances concur to render it, at least probable that they do not. The first is, that the space occupied by any particular colour, in the prismatic picture, is so much wider than the aperture, through which the light is admitted upon the prism, for the experiment. For, if all the rays of that colour were equally refrangible, the picture could be no wider than the aperture; and would be terminated by well defined edges: which is the result of this law of refractions, that parallel rays, of the same refrangibility, perpetually maintain their parallelism. The second circumstance is, the unequal widths of the several colours in the prismatic picture. Now, as this cannot arise from the greater or less quantity of rays, which would produce only different degrees of intensity, it must proceed from this: that the rays of those colours which form the widest pictures, possess different degrees of refrangibility among themselves: in consequence of which, they are scattered over a greater space. This being allowed, it is highly probable, that some red, and some yellow rays may be equally refrangible; in which case, they must, at their exit from the prism, be necessarily blended. The same may hold good of the other rays, some yellow and blue, some blue and violet remaining unseparated; from all which combinations will arise the orange, green, and purple colours.

Should it be here asserted, that these arguments prove only that rays of the same colour, suffer a dispersion from the imperfection of the refracting medium, I would answer, that although it would be impossible to account for the
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second appearance above mentioned, and its uniformity in all experiments, on this supposition ; yet, if granted, it will answer all the purposes of my argument : for this dispersion of rays, however occasioned, whether by a different refrangibility in rays of the same colour, or by the imperfection of the prism, will occasion an intermixture of neighbouring, simple colours ; from which the same compound colours must proceed, that are produced by the same mixtures in bodies, with which we are more intimately acquainted.

I know not with what force these reasonings will strike those, who are not influenced by the partiality which a man commonly feels for his own ideas ; but to me, they appear sufficient to warrant a modest conviction, that the original colours, or those inherent in the rays of light, ought to be reduced to these four, Red, Yellow, Blue, and Violet ; and that the other three, Orange, Green, and Purple, though among the most pleasing colours, should be degraded from the rank, which they have long unjustly held ; and considered as only some of the most simple of those, that are formed by composition.

After all, Sir, I am sensible it will be said, that in such enquiries, experiment is the only test of truth. It happens rather unfortunately for me, that, if I am right in my principle, that rays of the same colour possess different degrees of refrangibility, the case hardly admits of an experiment which can be decisive. On the other hand, if what I impute to this cause arise entirely from the imperfection of the prism, a second prism, so placed as to take only one of those colours, which I esteem compound, might determine the point. For instance, if orange be an original colour, the second prism

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could produce no change in it : but, if it be a compound, this second operation, by separating the red from the yellow rays, would annihilate it. But, on the former hypothesis, that some red, and some yellow rays may be equally refrangible, this experiment would be indecisive ; because no separation would be effected by it. I think of one experiment, by which (if it be practicable) some light may be thrown on the subject, though perhaps, not sufficient to discover where the truth lies. This is, to place four prisms in such situations, that the red rays of one, and the yellow of another, may be thrown together by the other two. If the common prismatick orange should be thus produced, it would be a strong circumstance in favour of my hypothesis.

As I have no prisms within my reach, to make these, or any other experiments, relative to the subject, it is not in my power. As I wish to have my ideas either verified or disproved, if you have among your acquaintance any one, who, being possessed of the necessary apparatus, will take the trouble of making some few such experiments, as the hints I have given, or his own ingenuity, may suggest, you will oblige me by turning his attention to the subject. And should you judge this epistolary essay to be worthy of the notice of the American Academy of Arts and Sciences, I beg you will do me the honour to present it.

I am, my dear Sir,

with every sentiment of esteem,

your most devoted,

and humble Servant,

SAMUEL TENNEY.

The Rev. Mr. BELKNAP, F. A. A.

II. *Ans*